CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/21**

Paper 2 AS Level Structured Questions **October/November 2024**

MARK SCHEME

Maximum Mark: 60

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

Abbreviations

/	Alternative and acceptable answers for the same marking point.
( )	Bracketed content indicates words which do not need to be explicitly seen to gain credit but which indicate the **context** for an answer. The context does not need to be seen but if a context is given that is incorrect then the mark should not be awarded.
___	Underlined content must be present in answer to award the mark. This means either the exact word or another word that has the same technical meaning.

Mark categories

B marks	These are <u>independent</u> marks, which do not depend on other marks. For a **B** mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer.
M marks	These are <u>mandatory</u> marks upon which **A** marks later depend. For an **M** mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer. If a candidate is not awarded an **M** mark, then the later **A** mark cannot be awarded either.
C marks	These are <u>compensatory</u> marks which can be awarded even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known them. For example, if an equation carries a **C** mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C** mark is awarded. If a correct answer is given to a numerical question, all of the preceding **C** marks are awarded automatically. It is only necessary to consider each of the **C** marks in turn when the numerical answer is not correct.
A marks	These are <u>answer</u> marks. They may depend on an **M** mark or allow a **C** mark to be awarded by implication.

Question	Answer	Marks
1(a)	mass per unit volume	**B1**
1(b)(i)	density = 0.243 / (0.0541 × 0.1109 × 0.0162)	**C1**
	= 2500 kg m^{-3}	**A1**
1(b)(ii)	(0.001 / 0.243) **or** (0.01 / 5.41) **or** (0.01 / 11.09) **or** (0.01 / 1.62)	**C1**
	$(\Delta\rho / \rho) = (\Delta m / m) + (\Delta x / x) + (\Delta y / y) + (\Delta z / z)$ = (0.001 / 0.243) + (0.01 / 5.41) + (0.01 / 11.09) + (0.01 / 1.62) (= 0.013)	**C1**
	percentage uncertainty in ρ = 0.013 × 100 = 1.3% (allow 1 s.f. answer of 1%)	**A1**
1(c)	zero error (on calipers / balance) **or** incorrect calibration (of calipers / balance)	**B1**

Question	Answer	Marks
2(a)	product of mass and velocity	**B1**
2(b)(i)	maximum speed $= 7.2 \times 10^4 / 1800$ $= 40\ \text{m s}^{-1}$	**A1**
2(b)(ii)	kinetic energy $= \frac{1}{2} mv^2$	**C1**
	$= \frac{1}{2} \times 1800 \times 40^2$ $= 1.4 \times 10^6\ \text{J}$	**A1**
2(b)(iii)	a = gradient of line / mass **or** $a = (v - u) / t$ **or** $a = \Delta v / t$	**C1**
	a = e.g. $(3.6 \times 10^4) / (4.0 \times 1800) = 5.0\ \text{m s}^{-2}$ **or** a = e.g. $20\ (-0) / 4 = 5.0\ \text{m s}^{-2}$ **or** F = e.g. $3.6 \times 10^4 / 4.0 = 9.0 \times 10^3$ **and** $a = 9.0 \times 10^3 / 1800 = 5.0\ \text{m s}^{-2}$	**A1**
2(b)(iv)	distance $= \frac{1}{2} \times 40 \times (8 + 4)$ **or** distance $= \frac{1}{2} \times 72\,000 \times (8 + 4) / 1800$ **or** distance $= [40^2 / (2 \times 5)] + [40^2 / (2 \times 10)]$ **or** distance $= \frac{1}{2} \times 5 \times 8^2 + (40 \times 4 - \frac{1}{2} \times 10 \times 4^2)$	**C1**
	distance = 240 m	**A1**

Question	Answer	Marks
2(c)	stepped shape, showing one constant value up to 8.0 s then stepping to a different constant value from 8.0 s with no time delay	**B1**
	horizontal straight line from (0, 5.0) to (8.0, 5.0)	**B1**
	horizontal straight line from (8.0, –10.0) to (12.0, –10.0)	**B1**

Question	Answer	Marks
3(a)	product of force and displacement in direction of force	**B1**
3(b)	weight/force = mg, and g identified as acceleration of free fall	**B1**
	ΔE_P identified as work (done by lifting force/weight), and so = $mg \times \Delta h$	**B1**
3(c)(i)	$240 \times 150 = 36$ kJ	**A1**
3(c)(ii)	$P = W / t$	**C1**
	$= 36\,000 / 60$ $= 600$ W	**A1**
3(c)(iii)	efficiency = <u>useful</u> output power / total input power	**C1**
	$= 600 / 900$ $= 0.67$	**A1**
3(c)(iv)	$P = I^2R$ **and** $R = \rho L / A$	**C1**
	$280 = I^2 \times (1.7 \times 10^{-8} \times 23) / (2.6 \times 10^{-8})$	**C1**
	$I = 4.3$ A	**A1**

Question	Answer	Marks
4(a)	stress per unit strain	**B1**
4(b)(i)	straight line with positive gradient passing through origin	**B1**
4(b)(ii)	spring constant	**B1**
4(b)(iii)	elastic potential energy (stored in wire)	**B1**
4(c)	length (of Q) is half (the length of P)	**B1**
	extension is proportional to length, and inversely proportional to area and Young modulus	**B1**
	extension of Q is = ½ / (2 × 2) = ⅛ times the extension of P	**B1**

Question	Answer	Marks
5(a)(i)	$P = 40$ **and** $R = 0$	**A1**
	$Q = 20$ **and** $S = -1$	**A1**
5(a)(ii)	(electron) antineutrino	**B1**
5(a)(iii)	leptons	**B1**
5(b)	(alpha particle consists of) 2 protons and 2 neutrons	**C1**
	quark composition of proton = up up down **or** quark composition of neutron = up down down	**C1**
	quark composition (of alpha particle) = 6 up, 6 down	**A1**

Question	Answer	Marks
6(a)(i)	for maximum intensity, waves must be in phase (at detection)	**B1**
	(phase difference at source means) waves are not in phase / have a 90° phase difference at O	**B1**
6(a)(ii)	point B labelled on the line PQ below O	**M1**
	distance OB = distance OA	**A1**
6(b)(i)	$v = f\lambda$	**C1**
	$\lambda = (3.00 \times 10^8) / (2.5 \times 10^{10}) = 0.012$ m	**A1**
6(b)(ii)	$\Delta x = 0.012 / 4$ $= 0.0030$ m	**A1**
6(b)(iii)	$\lambda = ax / D$	**C1**
	distance $= \lambda D / a = 0.012 \times 2.3 / 0.18$ $= 0.15$ m	**A1**

Question	Answer	Marks
7(a)(i)	(V =) 1.50 – 1.36 (= 0.14 V)	**B1**
	current = V / R = 0.14 / 0.28 = 0.50 A	**A1**
7(a)(ii)	resistance = V / I	**C1**
	= 1.36 / 0.50 = 2.7 Ω	**A1**
7(a)(iii)	R = 2.7 – 1.0 = 1.7 Ω	**A1**
7(b)(i)	two resistors correctly shown in parallel with cell and no other components	**B1**
7(b)(ii)	(external) resistance is now smaller **and** (so) current (in cell) is greater / (external) resistance smaller fraction of total resistance / internal resistance larger fraction of total resistance	**B1**
	(greater p.d. across internal resistance so) terminal p.d. is less	**B1**